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RESTRICTED

MINISTRY OF SUPPLY

AEROPLANE AND ARMAMENT EXPERIMENTAL ESTABLISHMENT

BOSCOMBE DOWN

WYVERN S. MK.4 VW.684
(PYTHON 3)

PRELIMINARY DIRECTIONAL HANDLING ASSESSMENT

AAEE Form 1.

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3rd Part of Report No. AAEE/853/2

30 JAN 1953

AEROPLANE AND ARMAMENT EXPERIMENTAL ESTABLISHMENT
BOSCOMBE DOWN

Wyvern S. Mk.4 VW. 884
(Python 3)

Preliminary directional handling assessment

A. & A.E.E. Ref: 5720,h/11/THJH
M. O. S. Ref: 7/Acft/5909/RDN1
Period of Tests: September and October 1952

Progress of issue of Report

Report No.	Title
1st Part of AAEE/853/2	VW.885 Cockpit Assessment.
2nd - do -	VW.884 Airfield Deck Landing Assessment.

Summary

Tests on Wyvern S Mk.4 VW. 884 showed that rudder overbalance was present under sideslip on the climb at 165 knots I.A.S. both with the standard Mk.4 fin and rudder and with several modifications. This overbalance characteristic is considered to make the aircraft unsuitable for service use in its present form, and further development work is necessary to arrive at a solution, if necessary at least sufficient to allow restricted use of the aircraft for familiarisation duties, but work should also proceed with a view to giving rudder characteristics satisfactory for a full clearance. Any scheme developed must not give rise to foot forces in the out of trim dive higher than those at present obtaining.

The aircraft was still subject to directional unsteadiness in the dive and, although this characteristic would not preclude restricted use of the aircraft, improvement may be necessary for the full clearance.

Work is proceeding at the firm and A. & A.E.E. to find some short term palliative for the overbalance problem, avoiding large modifications, which will allow a limited number of aircraft to go into Service quickly. The firm are also attempting to develop a positive cure to allow unrestricted use of the aircraft.

This Report is issued with the authority of

Air Commodore
Commanding A. & A.E.E.

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1. Introduction

Handling tests were required on Wyvern S Mk.4 VW. 884 as part of the programme for CS(A) release. The tests early showed that rudder overbalance was present under sideslip conditions, that there were directional changes of trim with speed and difficulty in trimming accurately for straight flight (as noted previously on the Wyvern 2, see for example the 6th part of Report No. AAEE/853/1). Various changes to the tail unit in efforts to overcome the overbalance were proposed at meetings between Ministry of Supply (RDN), RAE, Messrs. Westlands and this Establishment. The effect of these modifications was assessed on VW. 884 at this Establishment. None of the changes gave sufficient improvement to the overbalance characteristics, but the tests made are reported here for record purposes.

Further work on the overbalance problem is in progress and the results of further tests, to be made when satisfactory directional characteristics have been obtained, will be given in a later part of this Report.

2. Condition of aircraft

2.1 General. The aircraft was basically as described in the 2nd part of this Report. Some details are repeated here for ease of reference, together with details of the changes made to the tail unit.

2.2 Loading. The tests were made with the aircraft loaded to a weight at take-off of 20,730 lb. with the c.g. 6.0 ins. aft of datum (21.2% S.M.C.) undercarriage down (this is the design aft limit) i.e. 7.2 ins. aft of datum, 22.5% S.M.C., undercarriage up.

2.3 Relevant airframe limitations

Maximum permissible airspeed	- 435 kts. I.A.S.
Maximum design (AP.970) sideslip angles	- $16\frac{1}{2}^{\circ}$ up to 250 kts. I.A.S. 8° at 350 kts. I.A.S. 4° at 435 kts. I.A.S.

2.4 Engine installation. The engine fitted was a Python Mk.3, No. ASP 211/A/64460. The propellers fitted were Rotol 8 blade contra-rotating type RF. 75/4-40-5.5/5 (front) and RB. 75/4-40-7.5/5 (rear). These differed from those fitted to the Mk.2 Wyvern in having increased taper from approximately 0.7 radius to the tip to reduce the blade bending moment. The blade drawing No. was RA. 25706/2.

The propellers were "phased" to give equal torques at aircraft forward speeds between 350 and 400 kts. I.A.S.

The engine limitations for the climb were 7800 rpm with a maximum jet pipe temperature of 560°C.

2.5 Rudder and fin details. A diagram of the rudder as originally fitted to VW. 884 is given in Fig.3.

Stage 1 tests. Details appropriate to the aircraft in its original condition are given below.

The leading edge of the rudder above the top hinge was extended forward to form a 'horn balance'. The rest of the rudder leading edge, between the top and bottom hinges, was shrouded by rearward extensions of the fin skinning. The gap between the fin and the rudder nose was fully sealed by rubberised fabric.

The rudder tab could be adjusted on the ground to give, in addition to its normal trim function zero balance or 0.312:1 balance. The latter setting was used for the first series of tests.

Gross fin and rudder area	50.2 sq.ft.
Gross rudder area	17.1 sq.ft.
Rudder area aft of hinge line	13.3 sq.ft.
Horn balance area above top hinge and forward of hinge line	0.97 sq.ft.
Tab area	1.59 sq.ft.
Rudder travel	15° each way.

Stage 2 tests. As above, except that the rudder balance tab was adjusted to give zero balance.

Stage 3 tests. As for stage 2, except that the rudder shrouds were removed.

These tests were made only by the firm's pilot.

On completion of these tests, the fin and rudder were removed and a replacement fin and rudder with shrouds fitted. This was necessary because it was considered inadvisable to continue flying with an exposed seal, it being easier to fit a new fin and rudder than to replace the shrouds, which on one side are an integral part of the fin skinning.

Stage 4 tests. Aircraft as in Stage 2. Tests made to ensure that no differences arose due to fitting replacement fin and rudder.

Stage 5 tests. As stage 4, with the addition of a dorsal extension to the fin. (see Photograph).

2.6 Aileron details.

Gross area	21.24 sq.ft. each aileron.
Area aft of hinge line	16.22 sq.ft. each aileron.
Spring tab area	1.44 sq.ft. each aileron.
Spring tab rate	255 lb. ft/radian.
Trim tab area	0.955 sq.ft. port aileron only.

2.7 Airspeed system. This consisted of a Mk. 8M pitot head under the port wing and a static vent on the port top side of the fuselage just forward of the fin. Further details are given in the 2nd part of this Report.

2.8 Instrumentation. A Hussenot A.20 continuous trace recorder was used to record rudder force, rudder angle, height and indicated airspeed. A sideslip vane was fitted on a pole on the starboard wing tip and was connected to a desynn indicator in the cockpit.

3. Scope of tests

Tests made consisted of steady straight sideslips to port and starboard on the climb at 165 kts. I.A.S. at about 10,000 ft. and 190 lb/sq.in. torquemeter reading, and out of trim dives to the limiting speed of 435 kts. I.A.S.

4. Results of tests

The results are summarised in the following table. Foot forces quoted are nett values (i.e. port minus starboard or vice versa) from the Hussenot recordings, samples of which are given in Fig.2.

Figures in brackets are approximate sideslip angles.

Tests at Stage 3 (shrouds off) were made only by the firm's pilot concurrently with the air test following removal of the shrouds.

/Table.....

Stage	Sideslips on climb, trimmed* at 165 kts. IAS		Out of trim dives.
	To Port	To Starboard	
1	Foot force increased linearly to 55 lb. at 7° rudder, lightening to 45 lb. at 9° with buffeting, decreasing rapidly then at 10° (13°) 60 lb. port rudder force used to centralise.	55 lb. force at 8°, lightening with buffet to 30 lb. at 10° (13°) Rudder then locked over without warning. Force to centralise certainly not less than 250 lb.	Trimmed @ 15,000 ft. 160 lb. torque, 220 kts. IAS (cruise condition) Starboard foot force of 90 lb. at 435 kts. I.A.S.
2x	Force increased progressively to 88 lb. at 6°, lightening to 84 lb. at 7½° (11°).	Similar to port sideslip test.	Trimmed as for Stage 1, the starboard foot force was 118 lb. at 410 kts. IAS, the highest speed reached.
3	Reported to be similar to Stage 2.	Reported to be similar to Stage 2.	None performed.
4	No appreciable change compared with stage 2.		
5	68 lb. at 6° lightening to 53 lb. at 8½° (12°). Test stopped here since rudder appeared to be moving over of its own accord.	48 lb. at 7° lightening to 26 lb. at 8½° (11°).	Trimmed as for Stage 1, 80 lb. Starboard foot force required at 435 kts. I.A.S.

In all the above tests, lightening of the rudder bar forces was accompanied by buffeting. During the dives, directional unsteadiness was observed as on previous Wyverns. The aircraft was difficult to fly in any turbulence without some sideslip, which would change sign erratically. Further there appeared to be slight bodily movement sideways in bumps or following slight rudder movement. This characteristic was not noticeably affected by the dorsal fin.

Pilots again commented during these tests on the too rapid action of the rudder trimmer and considered that a slower action was necessary, thus allowing finer trimming.

5. Discussion of results

The straight sideslip tests used by this Establishment when checking for rudder overbalance have been chosen as the most suitable for this purpose. Although it is, of course, recognised that Service pilots do not maintain straight sideslips in this way, such conditions of sideslip with corresponding rudder angles are liable to occur in severe evasive manoeuvres or in misperformed aerobatics. It is concluded from the tests recorded in this part of the Report that rudder overbalance is liable to occur in Service use with any of the configurations tested to date. This is in contravention of AP. 970, Chap. 601, and is particularly unacceptable when very large control forces are needed to centralise the rudder, as is the case in the present instance. It is considered essential therefore that further development work be done in an attempt to eliminate the overbalance. It is understood that it is particularly necessary, in view of the urgent need to form a Service squadron, to find some solution avoiding large modifications, which could be easily applied to the small number of aircraft (18) required for the first squadron. Such a solution could, for instance, consist of making the rudder so heavy that the critical sideslip angle would not be reached, or reached only with difficulty.

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* As noted on previous Wyvern aircraft (e.g. see 6th part of A&AEE/8531/1) accurate directional trimming was virtually impossible, any slight disturbance making the aircraft fly with a degree or so of sideslip, which would often change sign in further disturbances.

x In this and subsequent stages, rudder angle was increased only to the point of buffet and lightening of the pedal forces.

Should a satisfactory scheme be developed, it will be tested on VW. 884 and the tests will include sideslips at higher speeds and in the flaps and undercarriage down case.

It is, however, essential that any scheme used should not give rise to higher foot forces in the out-of-trim dive than were experienced in these present tests; in fact lower forces are desirable.

The rudder trimmer was considered to be too rapid in operation. This feature aggravated the difficulty of trimming the aircraft accurately.

This aircraft in common with previous Wyverns, exhibited directional unsteadiness in the dive in that it appeared to move bodily sideways in bumps. It is pointed out that improvement in this respect may be necessary for unrestricted clearance of the aircraft, although it is appreciated that this will probably be difficult. It would not however preclude an interim release of the aircraft for familiarisation duties excluding the use of armament or external stores.

6. Conclusions

Tests on Wyvern S Mk.4 VW. 884 showed that rudder overbalance was present under sideslip on the climb at 165 kts. I.A.S. both with the standard Mk.4 fin and rudder and with several modifications. This overbalance characteristic is considered to make the aircraft unsuitable for Service use in its present form, and further development work is necessary to arrive at a solution, sufficient at least to allow restricted use of the aircraft for familiarisation duties, but work should also proceed with a view to giving rudder characteristics satisfactory for a full clearance. Any scheme developed must not give rise to foot forces in the out of trim dive higher than those at present obtaining.

The aircraft was still subject to directional unsteadiness in the dive and although this characteristic would not preclude restricted use of the aircraft, improvement may be necessary for the full clearance.

7. Further developments

Work is proceeding at the firm and A. & A.E.E. to find some short term palliative for the overbalance problem avoiding large modifications, which will allow a limited number of aircraft to go into Service quickly. The firm are also attempting to develop a positive cure to allow unrestricted use of the aircraft.

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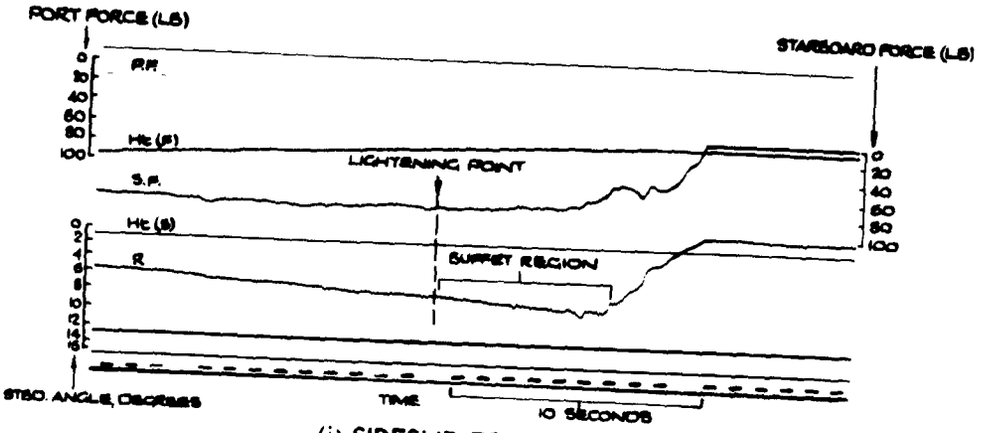
FIG. 1.

[A.& A. E. E. NEG No 1587 3]

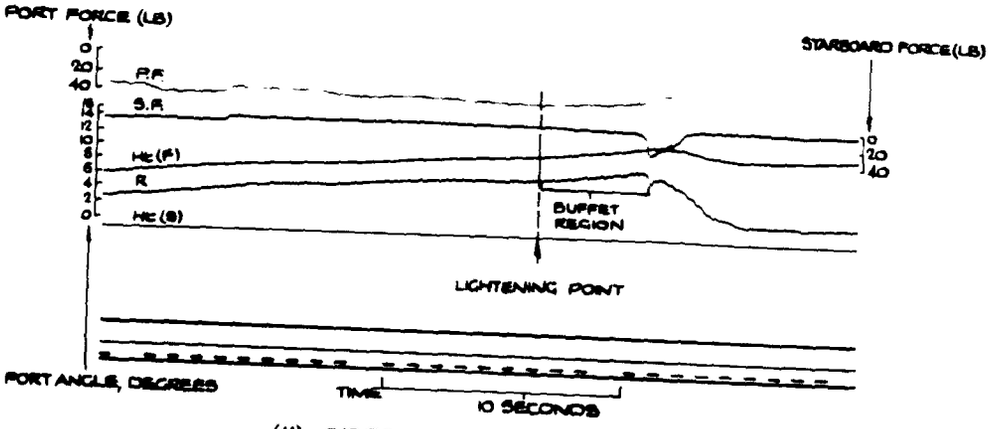
FIG.2

CLIMB AT 165 KTS. I.A.S.
14,000FT. APPROX.



(i) SIDESLIP TO PORT.

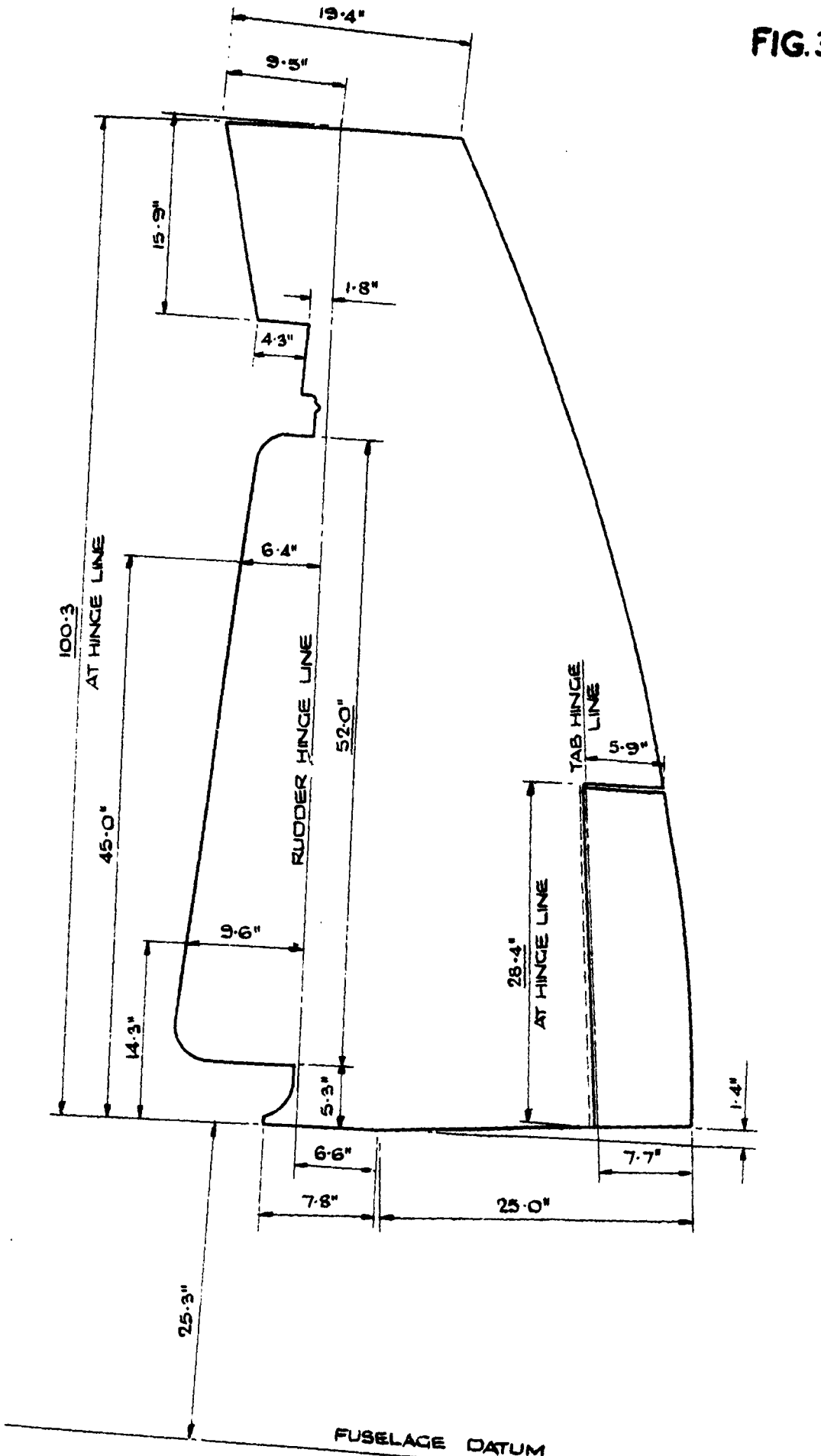
KEY:- P.F. - PORT PEDAL FORCE.
S.F. - STARBOARD PEDAL FORCE.
R. - RUDDER ANGLE.
Ht.(F) - FAST ALTIMETER TRACE.
Ht.(S) - SLOW ALTIMETER TRACE.



(ii) SIDESLIP TO STARBOARD

SAMPLE HUSSENOT RECORDS OF STRAIGHT SIDESLIPS.
DORSAL FIN FITTED.

FIG. 3.



DETAILS OF RUDDER.

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